1.0 INTRODUCTION

This report, "Management Options for the Estero Bay Watershed," forms Volume D of a series of reports developed for the South Florida Water Management District's (SFWMD) Estero Bay and Watershed Assessment Plan. Reports in the Estero Bay and Watershed Assessment Plan series are listed below.

- Volume A. Literature Survey of the Estero Bay Watershed
- Volume B. Characterization Report
- Volume C. Basin Prioritization Report
- Volume D. Management Options Report
- Volume E. Monitoring Report
- Volume F. Estero Bay Research Plan

The purpose of the Management Options Report is to identify and evaluate management techniques and strategies that could be implemented in the Estero Bay Watershed. This report is not intended to be a management plan or a permitting guide or manual. This report is designed to establish a foundation for future management strategies and a framework for the future identification and evaluation of management options.

Establishing a foundation and framework is important for two reasons. First, it assures that a method for approaching and evaluating management options will be in place if problems are identified in the Estero Bay Watershed. Second, it allows data that are collected in future monitoring and watershed studies to be considered in the light of potential management options. This is an important aspect of "adaptive management" techniques in which monitoring and management options are continually evaluated and revised as new data become available

The Management Options Report emphasizes general watershed issues. It is designed as a document with long-term relevance and value. As such, it does not discuss or emphasize specific, issued, or pending permits.

1.1 Background

Estero Bay has long been recognized as one of Florida's significant natural resources. The Bay was designated as the State's first Aquatic Preserve. The Bay's watershed also has a long history of both pre-Columbian and modern settlement and agriculture. The area in and around the Estero Bay Watershed has undergone a dramatic increases in the rate of residential and commercial development as well as population growth during the past 15 years. As a result, a series of initiatives have been proposed to balance development and environmental interests in the region. These initiatives are listed below and are discussed at length in other volumes of this report:

- Arnold Committee;
- Estero Bay Agency on Bay Management;
- Charlotte Harbor National Estuary Program;
- Corps of Engineers Environmental Impact Statement; and the
- South Lee County Watershed Plan.

1.2 Study Area Characteristics

This report describes and analyzes management options for Florida's Estero Bay Watershed. The watershed includes a portion of Lee County south of the Caloosahatchee River, parts of northeastern Collier County, and a small area of Hendry County (Figure 1.1). A substantial portion of the northern watershed area is within the City of Ft. Myers. Other population centers in the watershed are Bonita Springs and the City of Ft. Myers Beach.

The Estero Bay Watershed includes all of Estero Bay, most of which lies within the Estero Bay Aquatic Preserve, and the adjacent barrier islands. Hendry Creek, Mullock Creek, the Estero River, areas of Corkscrew Swamp, Flint Pen Strand, Spring Creek, and the Imperial River are major surface water features in the watershed. Hendry Creek, Mullock Creek, Estero River, Spring Creek, and the Imperial River experience some degree of tidal influence. The portion of the Estero River east of U.S. 41 is a slow conveyance system and is considered a recharge area along with the Imperial River east of I-75. Most local drainage canals provide some regional flood protection during wet periods, but also lead to over-drainage during dry periods.

The Estero Bay Watershed is divided into nine secondary basins for the purpose of this report. These basins are listed below.

- Estero River
- Spring Creek
- Hendry Creek
- Mullock Creek
- Six-Mile Cypress Slough
- Ten-Mile Canal
- Cow Creek
- Imperial River
- Barrier Islands

These basins were determined by the boundaries of surface hydrology features. Cow, Hendry, and Mullock creeks are coastal basins that flow into north Estero Bay. Six-Mile Cypress Slough and Ten-Mile Canal do not have direct discharges to the bay, but they are important sources for Mullock Creek, which flows directly into the bay. The Estero River and Spring Creek flow into Estero Bay

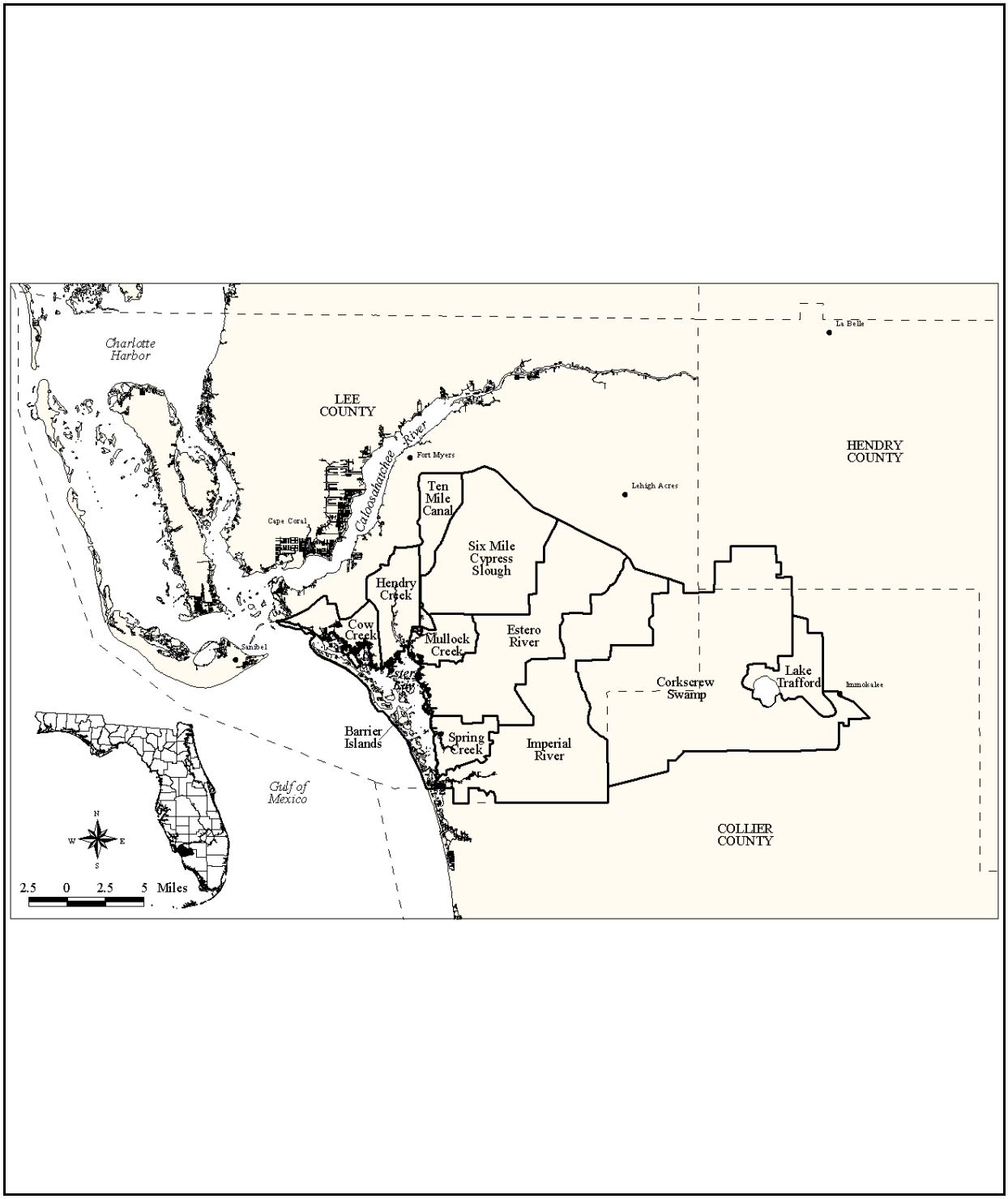

Figure 1.1. The Estero Bay Watershed and associated secondary basins.

in the central and southern potions of the bay. The Barrier Islands Basin contains the coastal barrier-islands, along the western length of Estero Bay.

The Estero Bay Watershed encompasses a total of 192,468 acres. The Imperial River, Estero River, and Six-Mile Cypress Slough basins each make up between 35,000 and 54,000 acres and together make up almost 70% of the watershed. Cow Creek, Ten-Mile Canal, Hendry Creek, Spring Creek, and Barrier Islands basins are much smaller, each making up no more than 8% of the entire watershed. The areas of all subbasins are given in Table 1.1.

Table 1.1. Acres and percentage of watershed for the nine secondary basins in the Estero Bay Watershed.

SECONDARY BASIN	ACRES	PERCENT
Ten-Mile Canal	8,717	5%
Six-Mile Cypress Slough	35,027	18%
Mullock Creek	6,995	4%
Estero River	45,381	24%
Imperial River	53,664	28%
Cow Creek	7,985	4%
Hendry Creek	11,623	6%
Spring Creek	7,350	4%
Barrier Islands	15,726	8%
Total	**192,468**	

For purposes of this report's analyses, tertiary basins are defined as the watersheds of canals and natural channels that are directly tributary to the nine secondary basins. Figure 1.2 shows the locations and identifying numbers for all of the secondary and tertiary basins within the study area. A total of sixty-two tertiary basins were identified, ranging in size from 38 to about 41,600 acres.

1.3 Watershed Problems

There are several documented, predicted, and perceived problems in the Estero Bay Watershed. The problems are primarily related to: 1) conversion of natural habitats to agricultural, commercial, and residential land uses; 2) the construction of canals, ditches, and road beds; and

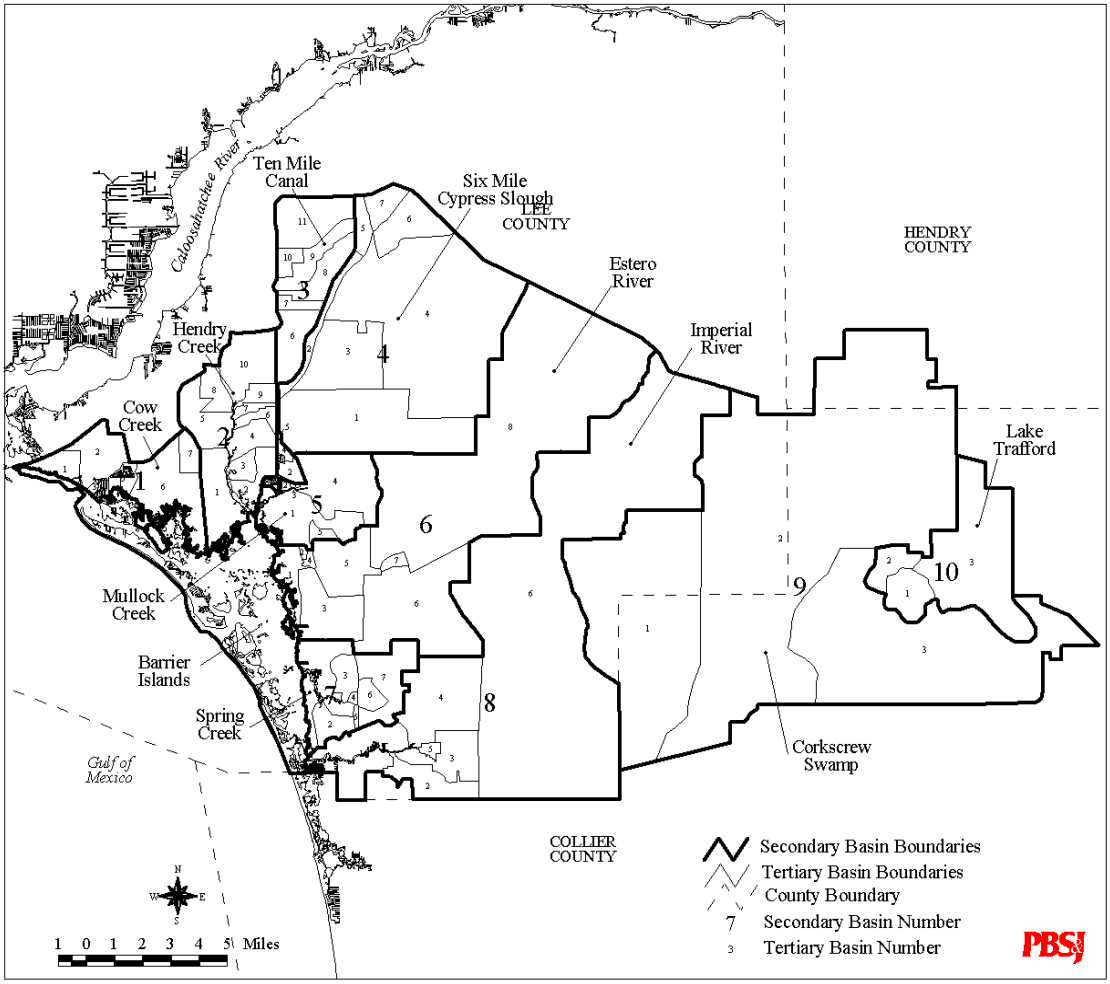

Figure 1.2. Secondary and tertiary basins within the Estero Bay Watershed.

3) filling, dredging, and draining of wetlands waterbodies that occur in association with the previous two factors. The watershed problems include:

- increased watershed size;
- increased freshwater inflows;
- increased nutrient and total suspended solids loading;
- lowered water tables;
- altered wetland and aquatic hydroperiods;
- loss of wetland, upland, and aquatic habitats; and
- downstream flooding.

Increased watershed size

The constituent basins of the Estero Bay Watershed were delineated as early as 1962 (Smalley, Welford, and Nalven, 1962). Even in 1962, these constituents had been altered from their pre-development condition by canals and roadbeds. The size of the effective watershed for Estero Bay has increased since pre-development and presumed 1962 conditions as a result of several factors. Prominent among these factors are constrictions or blocks in historic flowways that formerly allowed water from the watershed's eastern basins to flow south through Collier County.

Increased freshwater inflows

Residential, commercial, and agricultural development have changed and will continue to change the natural landscape within the study area. These changes have and will result in changes in the physical manner in which runoff responds to rainfall. Replacement of wetlands and forests with impervious surfaces, like asphalt pavement, rooftops, and concrete sidewalks, produces increased runoff rates from the land surface. Likewise, ditching and pumping increase runoff rates from agricultural areas. These increases have the potential to produce both an increase in the total freshwater discharges to the estuary and increase the magnitude of individual discharge events. On-site and regional stormwater management systems have been and continue to be constructed within the study area in an effort to ameliorate the impacts of these changes to the land surface. Insufficient data are available to determine the effect of both development and existing stormwater management practices on freshwater discharges.

Increased nutrient and total suspended solids loading

Increases in nutrient and total suspended solids loads are a frequent concern in watersheds undergoing significant urban and agricultural development. Implementing "best management practices" in new developments is a frequent solution. However, best management practices

minimize but do not necessarily eliminate the effect of new development on the watershed. The cumulative effects of several new development projects or the effects of new and old development combined, may degrade downstream waterbodies and estuaries.

Lowered water tables

The construction of canals and channelization of existing waterways has lowered the surficial water table in many portions of the study area. Tabb et al. (1976) describe the pre-development watersheds immediately south of Estero as areas where evaporation exceeds transpiration in many years and drought-conditions are averted by storage of water in shallow, sand filled basins during wet years. Tabb et al. describe a scenario in which canals breach these shallow basins and dissipate water reserves. This shallow-basin characterization applies to much of the Estero Bay Watershed. It is because the watershed is a series of shallow basins, that the watershed size has been significantly increased by seemingly minor alterations in topography and conveyance.

Water table declines have been purported causes for excessive wildfires (Tabb et al., 1976), melaleuca (*Melaleuca quinquenervia*) invasion patterns (Myers, 1983), and salinity intrusions in aquifers. Duever et al. (1978) suggested water-table declines might exacerbate winter freeze-damage after observing regional, frost-damage patterns that mirrored regional, water table-decline patterns.

Altered wetland hydroperiods

Ditching, filling, road beds, and urban and agricultural development have altered the hydroperiod of many of the wetlands in the study area. Most wetlands have been excessively drained, though a few may be over-hydrated. Duever et al. (1978) documented the negative effects of over-hydration. They found decreases in cypress growth as a result of excessive, prolonged flooding caused by berms in Corkscrew Swamp.

Loss of wetland, upland, and aquatic habitats

A large amount of upland and wetland habitat in the watershed has been converted to agricultural, residential, and commercial uses. Conversion appears to be continuing at equal or increasing rates. This habitat loss has the potential to effect several regionally or globally threatened or endangered species including the Florida panther (*Felis concolor coryi*), Florida black bear (*Ursus americanus floridanus*), red cockaded woodpecker (*Picoides borealis*), Big Cypress fox squirrel (*Sciurus niger avicennia*), wood stork (*Mycteria americana*), Southeastern American kestrel (*Falco sparverius paulus*), and Florida sandhill crane (*Grus canadensis pratensis*).

Downstream flooding

The 1995 wet season produced severe flooding in Bonita Springs located in the downstream reaches of the Imperial River subbasin. This flooding was particularly notable given that high flows were not documented in the adjacent, Estero River subbasin (Johnson Engineering Inc. et al., 1995). The South Lee County Watershed Study (Johnson Engineering Inc. et al., 1998) was conducted in response to this flooding. This flooding has been attributed to development in historic floodplains, land use changes, flowway constrictions, sub-basin reconfiguration, and agricultural pumping practices (Johnson Engineering Inc. et al., 1998).

1.4 Management Options

There are several management options available to address the problems identified in the Estero Bay Watershed. These options can be divided into two categories, "corrective" and "conservation." Corrective options are management tools that serve to correct problems that may already exist. Conservation options are tools to prevent future problems that may result as the area of developed land in the watershed increases.

Corrective Options

- Require Greater Stormwater Attenuation and Treatment
- Designate Nutrient Sensitive Basins and Permit According to Sensitivity
- Require Demonstrated Concurrency with Loads Reduction
- Construct Regional Treatment Facilities at Strategic, Downstream Basin-Nodes

Conservation Options

- Require Buffer Areas around Tributaries
- Require Upland Buffers/Components for Wetlands
- Preserve and/or Restore Regional Flowways (hydrologic and habitat corridors)
- Transfer Development Rights from Sensitive Areas
- Require Demonstrated Net-Benefits to Listed Species Recovery

1.4.1 Corrective Options

Corrective options are primarily designed to address existing or expected water quality issues.

Require Greater Stormwater Attenuation and Treatment

Requiring more stormwater attenuation and treatment would necessitate rule changes for state permitting agencies (SFWMD and DEP). This option is largely preventive, but partially corrective. The option is preventive when natural land covers are converted to other land uses. The option is corrective when a developed land use (agriculture or mining for example) is converted to another land use providing the original land use contributed to runoff and loading problems.

Nutrient Sensitive Basins - Designate and Permit Accordingly

Under this management option, other management options (like greater attenuation and treatment, demonstrated concurrency with loads reduction) would be implemented in the basins with the highest potential for or highest identified nutrient loading. This report identifies basins with the highest potential for nutrient loadings. This management option would involve specifically designating nutrient-sensitive subbasins. This designation can be made based on the potential nutrient loadings detailed in this report, or based on nutrient loadings calculated from data that will be collected in future monitoring efforts.

Require Demonstrated Concurrency with Loads Reduction

This option would require that new activities demonstrate contributions to reductions in hydrologic, nutrient, and total suspended solids loadings to Estero Bay. Implementing this option may be hindered by a lack of data on the effectiveness of various treatment methods and techniques within the Estero Bay Watershed

Construct Regional Treatment Facilities at Strategic, Downstream Basin-nodes

This is both a corrective and a preventive measure and should be implemented as such. The priority subbasins identified in this report are candidates for treatment facilities intended to serve as corrective measures. Subbasins with large areas of undeveloped land that are not in conservation are candidates for future treatment facilities to prevent future loading problems. The locations for future facilities should be identified and secured before they become prime development lands.

1.4.2 Conservation Options

Conservation options are designed to prevent future problems with water quality and habitat, but the options may also correct some existing problems.

Require Substantial Buffer Areas around Tributaries

Placing buffer zones around tributaries offers the opportunity to protect both the ecological integrity of the tributaries and downstream waterbodies. Buffers would help preserve both the habitat quality and water quality of the tributaries and Estero Bay.

Require Significant Upland Buffers/Components for Wetlands

Jurisdictional wetland boundaries are frequently artificial or legal boundaries that do not necessarily represent the edges of ecological systems. Jurisdictional boundaries are determined by the effect of

flooding and the resulting anaerobic conditions on vegetation and soils. As a result, significant ecological processes or functions inherent to the Estero Bay Watershed are only partially represented or contained within the wetland jurisdictional boundaries. Upland buffers for wetlands can affect wildlife habitat values, hydrologic functions, and water quality within the watershed.

Preserve and/or Restore Regional Flowways (hydrologic and habitat corridors)

This option is closely related to the tributaries buffer option. This option proposes to extend the buffer concept upstream to the wetland location of tributary water-flow origin. Landscape level connections like flowways were identified as early as 1975 by Brown (1975, 1976). The importance of such connections was also emphasized by the actions and reports of the Arnold Committee and the Agency on Bay Management. Flowways in the Estero Bay Watershed include water courses such as streams and rivers as well as connected wetlands in slough and marsh systems. These connected wetland systems were once "river-of-trees" analogs of the "river-of-grass" concept popularized for the eastern Everglades. Ditching, fill placement, and channelization have disrupted many of the historic flow patterns, but the basic flowway behavior remains in many places.

Flowway protection has the potential to provide both hydrologic protection as well as habitat protection. Habitat protection in the form of habitat connectivity is particular important. It helps maintain ecosystem functions that are expressed by ecosystems operating as whole units, but not by isolated, parts or sub-units of ecosystems.

Transfer Development Rights from Sensitive Areas

Under this alternative, development rights in sensitive areas would be exchanged for the right to increase development densities in less sensitive areas. There are several methods by which this could be accomplished, some of which are already in place. The initial emphasis of this option would be to implement transfers as a preferred alternative to sensitive area conversions or impacts within the watershed.

Require Demonstrated Concurrency with Listed Species Recovery

This option would require a project to demonstrate consistency with recovery of listed species with habitats within or adjacent to the project's boundaries. The concept is similar to demonstrated concurrency with reduction of nutrient and other loads. This would differ from current standards in that instead of proving that it would not impact species, a project would need to demonstrate that it did not impact the recovery of listed species. While seemingly semantic, the change is quite significant. The scope of compensatory-mitigation that contributes to the recovery of listed species can be quite different than the scope of mitigation that results solely in "no net impact" to listed species.

This option is not necessarily a blanket, preservation initiative. Requiring demonstrated concurrency with listed species recovery would discourage excessive efforts to preserve isolated habitat fragments that have lost the ability to contribute to species recovery. Mitigation for impacts to such habitat fragments would still be required, but the mitigation would be directed toward efforts that would aid in long-term species recovery rather that short-term preservation of isolated individuals.